

U.S. Patent Application Serial No. **09/504,923**
Amendment dated September 29, 2003
Reply to OA of **March 28, 2003**

REMARKS

Claims 2 and 12 have been canceled without prejudice or disclaimer; and claims 9 and 10 have been withdrawn..

Claims 1, 3 - 8, 11 and 13-17 have been amended in order to more particularly point out, and distinctly claim the subject matter to which the applicants regard as their invention. It is believed that this Amendment is fully responsive to the Office Action dated March 28, 2003.

Claims 1, 3 - 8, 11 and 13 - 17 remain in this application.

At the outset, in addition to withdrawing his previous indefiniteness rejection under 35 USC §112, the Examiner has now withdrawn his previous anticipation rejection under 35 USC §102(b) based on the European patent publication to Lu (of record), and his previous obviousness rejections under 35 USC §103(a) based on Lu, singly or in combination with the European patent publication to Akahori (also of record).

However, the Examiner now relies on the international patent publication to Meikle (WO 96/17104) in setting forth the following obviousness rejections:

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- (1) claims 1 - 6 and 11 - 16 stand rejected under 35 USC §103(a) based on Meikle;
- (2) claims 7 and 17 stand rejected under 35 USC §103(a) based on Meikle in view of Chern (U.S. Patent No. 6,500,742); and
- (3) claim 8 stands rejected under 35 USC §103(a) based on Meikle in view of Lu.

The applicant respectfully requests reconsideration of these rejections.

In the applicant's claimed invention, as now set forth in the amended claims filed herewith, it is clear that O₂ gas is introduced.

In Meikle, O₂ gas is not used. When comparing a process that uses O₂ gas with a process that does not use O₂ gas, the character of tungsten nitride film thus formed is quite different from each other.

When O₂ gas is added, variation of the flow rate among WF₆, SiH₄, O₂ and Ar, specially the flow rate between SiH₄ and oxygen, form two kinds of film having different structures, wherein one structure is a film having oxygen in its structure, and the other structure is a film having Si in its structure. The tungsten nitride film having oxygen can be denoted WON film, while the tungsten nitride film having Si can be denoted WSiN film.

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The applicant respectfully refers the Examiner to FIGS. A, B and C, attached herewith, which are graphs showing the results of values which the applicant had actually measured.

FIG. A shows a result of an Auger electron spectroscopy of a WON film, while FIG. B shows a result of an Auger electron spectroscopy of a WSiN film. The x-axis denotes sputtering time (i.e., film thickness in a depth direction).

The WON film is an amorphous structure (or a structure that is substantially amorphous), and the resistance is reduced at $200 \mu \Omega \text{ cm}$.

To the contrary, a WSiN film has a crystal structure (such as, a columnar structure); and the resistance is $1000 \mu \Omega$ or higher.

FIG. C shows graph which compares a resistance value of a barrier film made without O_2 , a barrier film made by adding 0.4 sccm of O_2 , and a barrier film made by adding 0.6 sccm of O_2 . The x-axis denotes a flow of SiH_4 gas. It is understood that the resistance is very high for the film without the addition of O_2 gas.

With regard to the ability of a barrier to Cu, a WNO film having amorphous structure (or a structure that is substantially amorphous) shows remarkable ability as a barrier. To the contrary, a

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WsiN film having a crystal structure does not show any ability as a barrier.

As described above, the presence of O_2 or the absence of O_2 provides different structures of the resulting film, and further results in a different composition. Moreover, there is a difference in ability of being a barrier film to Cu, and further different in terms of resistance. Therefore, the characteristics resulting from the addition of O_2 gas is an essential element in the applicant's instant claimed invention.

A tungsten nitride layer 50 formed by the primary reference of Miekle is a film for using a second electrode of a storage capacitor, and is not a barrier film (see, page 4, lines 13 - 15 in Miekle). This is the reason why O_2 gas is not used in Miekle.

As to the secondary references of Chern, lines 41 - 51, column 15 therein describe that the titanium nitride film absorbs oxygen when the film is exposed to the air because of the titanium nitride film includes carbon. However, there is no discussion in Chern of the introduction of O_2 gas when the film of nitride metal is formed.

Again, contrary to the applicant's claimed invention, neither Meikle or Chern describes the characteristic of forming tungsten nitride film with the introduction of O_2 gas.

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The other secondary reference of Lu is narrowly relied upon by the Examiner for merely teaching the exposure of the surface of the substrate to a plasma of hydrogen gas, and a plasma containing at least one gas selected from among argon, nitrogen and helium gases, but clearly fails to teach the above-discussed claimed structural arrangements or features of the applicant's claimed invention, as now recited in the amended claims filed herewith, and the advantages or benefits derived therefrom.

In view of the above, the applicant respectfully submits that his claimed invention, as now set forth in the amended claims submitted herewith, would not have been obvious to a person of ordinary skill in the art under 35 USC §103(a) based on Meikle, singly or in view of Chern or Lu.

Accordingly, the withdrawal of the outstanding rejections under 35 USC §103(a) based on Meikle, singly or in combination with Chern or Lu is in order, and is therefore respectfully solicited.

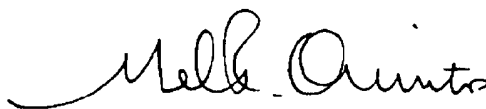
In view of the aforementioned amendments and accompanying remarks, claims, as amended, are in condition for allowance, which action, at an early date, is requested.

If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact the applicant's undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, the applicant respectfully petitions for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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PATENT TRADEMARK OFFICE

Enclosures: FIGS. A, B and C